CHAPTER 9

EMERGENCY GENERATOR SYSTEMS

9-1. General mechanical systems design

This chapter describes the basic system requirements for on-site generating units at C4ISR sites. Specific information about the major components and operation of a generating system and auxiliaries, such as the prime movers, lubricating systems, etc., can be found in TM 5-685, Operation, Maintenance, and Repair of Auxiliary Generators.

a. The design agency shall specify that mechanical equipment, such as hoists, vibration isolators, lubrication systems, radiators, etc., shall be of industry-standard sizes and types.

b. The design agency shall specify that the construction contractor procure a list of required machine lubricants from the equipment manufacturers. This list shall include special lubricants for unusual operating requirements such as extreme temperatures.

c. The design agency shall specify that equipment used to service and support principal facility equipment incorporate standards that create uniformity and interchangeability. When practical, the design agency shall standardize equipment used in quantities, such as cranes, lifts, and hoists, by specifying that it be purchased from one manufacturer.

d. Color-coded symbols per American National Standards Institute (ANSI) A13.1, Scheme for the Identification of Piping Systems, shall be used to identify the temperature, pressure, content, and direction of flow through air, water, lubricant, and fuel lines. Rotation codings on motor and generator housings shall be used to indicate the direction of rotation for normal operation of the machine.

9-2. Generator room or building

The generator room shall incorporate the following design features:

a. The generator room or building will be provided with an overhead I-beam rail or movable structure that will support a chain fall hoist to allow removal of cylinder heads, cylinder liners, pistons, etc. Adequate ceiling height and area lighting will be considered in the design of the generator room or building.

b. A generator and its prime mover should be set on a single, uniform foundation to reduce alignment problems. The foundation should be in accordance with manufacturer’s recommendations for proper support of equipment and dampening of vibrations. Foundation, prime mover, and generator should be mechanically isolated from the building floor and structure to minimize or eliminate transmission of vibrations to the permanent structure. Vibration isolators, as recommended by the manufacturer of the emergency generator, shall be installed either between the rotating equipment and its skid base or between the skid base and the foundation or inertia base. All mechanical and electrical connections to the generator set should allow for vibration isolation.

c. Design the generator room or building for noise attenuation in accordance with OSHA standards. Exhaust noise can be attenuated by using proper mufflers. To attenuate other noises, use line-of-sight acoustical barriers, acoustical enclosures, sound attenuating duct treatment, or install the generators away from critical areas.

d. The space around the generators should permit easy access for maintenance and repair.

e. The generator room wall shall be equipped with air intakes. The air intakes shall be in accordance with the manufacturer's requirements and dependent on the sizes and quantity of generator sets.

9-3. Diesel engine cooling systems

Diesel engines shall be liquid cooled. Liquid coolant systems consist of unit- mounted or remote fan-cooled radiators and water-cooled heat exchangers. Adequate freeze protection shall be provided for the engine cooling system.

a. Unit-mounted radiators are installed on the base of the generator set in front of the engine. The mounted radiator with a radiator fan is typically the most economical method of cooling an engine. The air stream drawn over the engine by the fan is pushed through the radiator. This action provides surface cooling for the engine together with cooling of the engine coolant in the radiator. Radiator and fan cooling is independent of potentially interruptible utility supplied cooling water. In addition, coolant can be treated rust inhibitors, anti-freeze, etc. Refer to figure 9-1, typical diesel engine liquid cooling system with radiator.

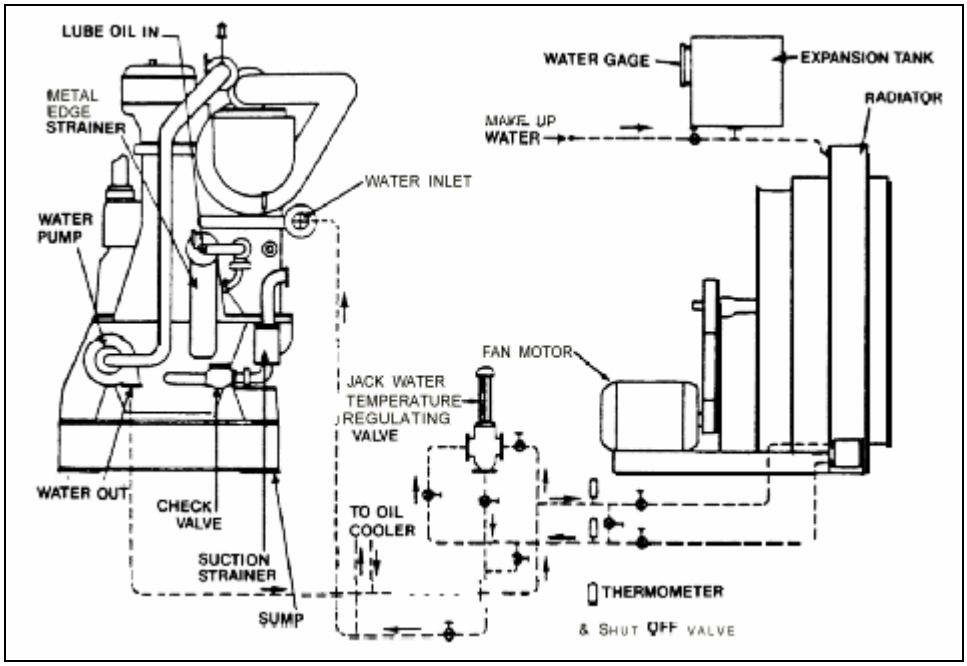

Figure 9-1. Typical diesel engine liquid cooling system with radiator

b. Some installations require the radiator and fan be mounted separately from the generator set. While these systems offer more versatility, might require less power for generator room ventilation, and can use low-noise fans, these systems are more expensive in original cost than the unit-mounted radiators. Also, application of a remote radiator requires careful planning and design to ensure proper cooling of the equipment. The design of this type of cooling system requires a qualified consulting engineer with hydraulic cooling system design experience. Remote radiator cooling installations will require high altitude electromagnetic pulse (HEMP) protection if site is HEMP protected.

c. Heat exchanger cooling eliminates the necessity of both a radiator and the associated cooling fan. Raw water or cooling tower water is used for cooling the engine coolant. Heat is radiated from the engine coolant to the heat exchanger. The heat exchanger radiates heat to the raw water or cooling tower water. The heat exchanger consists of tubing within a surrounding "shell." Engine coolant in the heat exchanger does not mix with the raw water or cooling tower water in the tubes. Raw water or cooling tower water passing through the tubes absorbs engine heat from the separated engine coolant in the heat exchanger shell. This type of cooling system also requires a qualified consulting engineer with hydraulic cooling system design experience for proper cooling of the equipment.

d. Cooling towers and evaporative coolers are both used to dissipate diesel engine heat to the atmosphere. They may be used where ambient air is sufficiently cool and dry (low relative humidity) to absorb water vapor. As water is sprayed or divided into many small streams, some will evaporate to the passing air. The air which is now moist may be warmed by the water (if the water was originally warmer than the air), thus removing more heat from the water. In a cooling tower, the fluid to be cooled is exposed to the air. Approximately 80 percent of the heat removed is due to evaporation. The tower may use atmospheric draft or fans to move the air. Makeup water is required to replace that lost by evaporation or entrained spray. Water treatment and blowdown are necessary because salts are concentrated by the evaporation. In an evaporative cooler, the coolant passes through tubes. The tube bundle lies inside the cooling tower. The cooling tower spray and air movement cool the tubes but do not mix with the coolant. A 30-minute backup supply of make-up water shall be provided for cooling towers and evaporative coolers serving C4ISR facilities.

9-4. Engine coolant heaters

The diesel generators must be easily started in all seasons of the year. Thermostatically controlled engine coolant heaters shall be provided to increase starting reliability, increase engine life, and increase generator set load acceptance. The engine water jacket heaters shall maintain the jacket water temperature at not less than 90^{O}F. All water jacket heaters shall be automatically deactivated while the diesel engine is running. Thermostats are used to control operation of the heaters by sensing coolant or engine block temperature. Engine coolant heaters shall be connected to the normal (commercial) power source.

9-5. Lubrication system

The bearings and moving parts of all diesel engines are lubricated by a full pressure lubrication system.

a. Lubricating systems of small engines usually are self-contained in the crankcase or a separate oil pan underneath the engine contains all the oil used in the system. Smaller engines will have many of the system elements used in the larger engines, such as a feed pump, piping, valves, controls, engine internal oil passageways, oil sump, oil filter, sampling valves, and transfer system for adding new oil and removing used oil from the engine. See figure 9-2 for a typical diesel engine lubrication system.

b. Because large engines require a large quantity of oil, a separate oil sump tank is installed to receive oil from the crankcase. The lubricating oil pump draws oil from the sump tank through the strainers. Oil is then discharged, under pressure, into the oil cooler. The oil then goes to a header, located on the engine, with branches leading to the various parts of the system.

c. Circulating lubricating oil absorbs heat from the engine. Frictional heat is absorbed from the bearings. The oil film on the cylinder walls absorbs heat from the combustion space before this oil film drains into the crankcase. Therefore, heat must be dissipated from the oil by an oil cooler to keep the

temperature below manufacturer's recommendation. Oil coolers should be placed in the oil circuit after the lubricating oil filter. The oil filter then handles hot oil of lower viscosity than if it received cooled oil. The filter performance is better and the pressure drop through it is less with this arrangement. Coolers are usually mounted on the side of the engine or on the floor alongside of the engine base. Cooling water passes through the oil cooler before entering the engine jacket. Consideration shall be given to providing diesel engine prime movers with lubricating oil heaters to ensure quick starting.

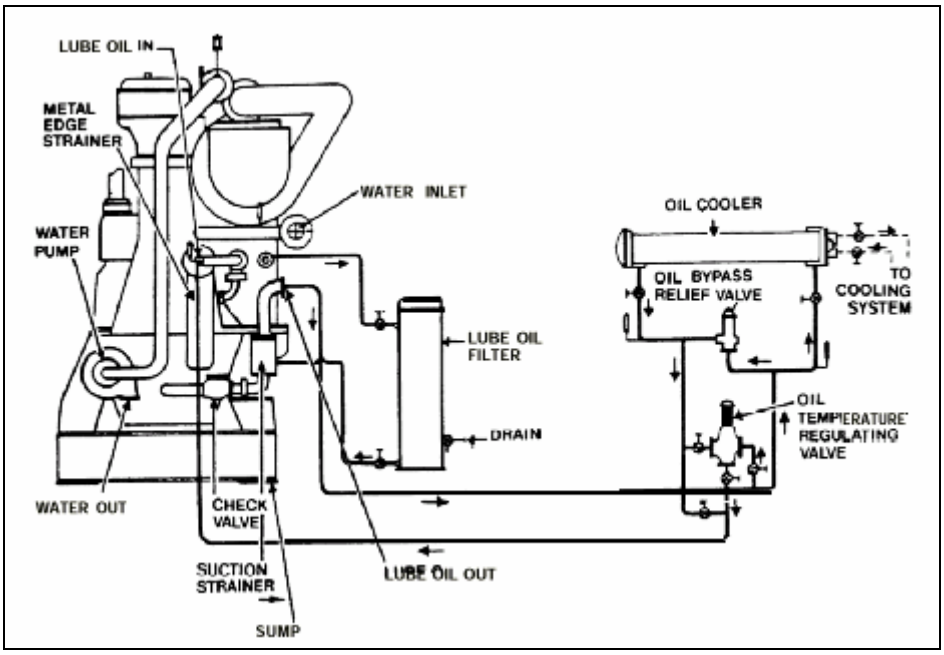

Figure 9-2. Typical diesel engine lubrication system

9-6. Engine protection

Engines of ten horsepower or more shall be equipped with automatic engine shutdown devices for high jacket water temperature or high cylinder temperature, low lubricating oil pressure or oil level, and engine overspeed/high speed. If the generator engine will be constantly attended, an alarm shall be permissible in lieu of the shutdown devices.